

Construction Stakeout With GPS



**Break-Out
Session
SUE & GPS**

Construction Engineers Conference

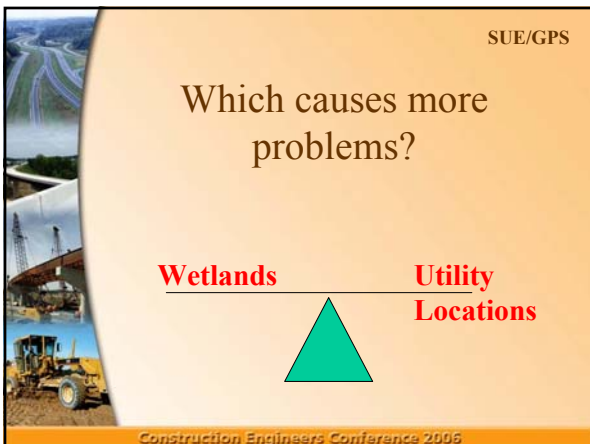
This slide features a collage of construction-related images on the left, including a road construction site, a bridge, and a yellow excavator. On the right, a construction worker in a white shirt, orange vest, and hard hat is using a GPS device on a tripod in a grassy field. The text 'Break-Out Session SUE & GPS' is centered in a large, bold, brown font. The footer reads 'Construction Engineers Conference'.



**Subsurface
Utility
Engineering
(SUE)**

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This slide features a collage of construction-related images on the left, including a road construction site, a bridge, and a yellow excavator. On the right, a construction worker in a white shirt, orange vest, and hard hat is using a GPS device on a tripod in a grassy field. The text 'Subsurface Utility Engineering (SUE)' is centered in a large, bold, brown font. The footer reads 'Construction Engineers Conference 2006'.



SUE/GPS

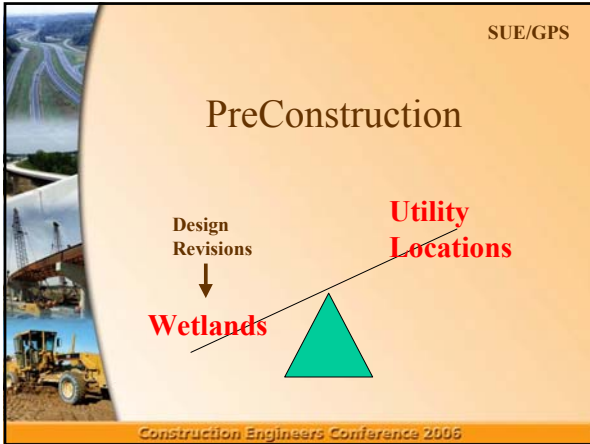
Which causes more problems?

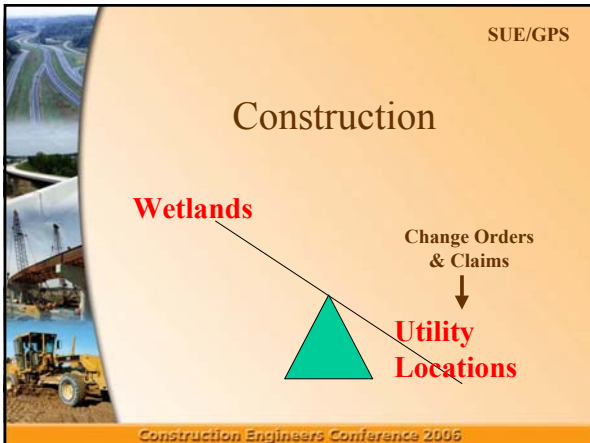
Wetlands **Utility Locations**

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This slide features a collage of construction-related images on the left, including a road construction site, a bridge, and a yellow excavator. On the right, a construction worker in a white shirt, orange vest, and hard hat is using a GPS device on a tripod in a grassy field. The text 'SUE/GPS' is in the top right corner. The main text 'Which causes more problems?' is centered. Below it, 'Wetlands' and 'Utility Locations' are written in red, separated by a horizontal line. A green triangle is positioned below the line, pointing upwards. The footer reads 'Construction Engineers Conference 2006'.


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SUE/GPS

This is applied to
Environmental Concerns

Can we use the same philosophy
with utility relocations?

If so...How ???

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SUE/GPS

SUE
(SUBSURFACE UTILITY
ENGINEERING)

A branch of engineering practice that
involves managing certain risks
associated with:

- utility mapping at appropriate quality
levels
- communication of utility data to
concerned parties

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SUE/GPS


**Basic Tenets of
Highway Construction**

Existing Utility Data as shown on plans
consists of different “quality levels” - in
other words, this data may be good, bad,
or non-existent.

Traditional engineering practice is to
depict all data the same, regardless of
how good it may be known to be, and to
disclaim any responsibility.

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SUE/GPS

Traditional Risk Allocation


Utility - Located to “Best Guess” accuracy

Engineer - Shifts all risk to contractor through “disclaimers” and notes.

Owner - Shifts risk to contractor by treating utilities as an “unknown or differing site condition”

Contractor - Puts contingencies in bid and documents problems for change orders and claims.

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SUE/GPS

“New” Risk Allocation


Utility - SUE data has an “attribute” consisting of its quality (D, C, B, or A)

Engineer - Makes prudent decisions based in part on achieved quality levels.

Owner - Notifies Contractor of appropriate level of accuracy

Contractor - Reduces change orders due to better design data

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SUE/GPS

SUE is recognized as a **BEST PRACTICE** by

- AASHTO
- Federal Highway Administration
- American Society of Civil Engineers
- Associated General Contractors
- Office of Pipeline Safety
- National Transportation Safety Board
- Many state DOTs

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SUE/GPS

SUE

Subsurface Utility Engineering

- NOT NC One Call
- Thorough Records Examination of all Utilities in the area
- Thorough sweep of area with state-of-the-art equipment
- Accurate surveys on plans
- Non-destructive exposure of utilities at critical points

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SUE/GPS

4 Quality Levels - D & C

D Information derived solely from existing records or verbal recollections. Plotted on available mapping

C Information obtained by surveying and plotting visible above-ground utility features and by using professional judgment in correlating this information to Quality Level D information.


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4 Quality Levels - B

SUE Location - records research, thorough ground sweep using Surface Geophysical methods, paint lines surveyed




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4 Quality Levels - A

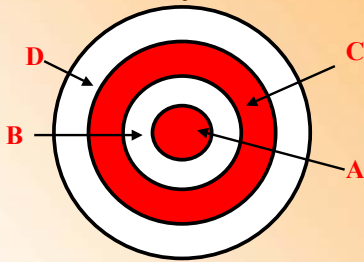
Utility exposed using non-destructive vacuum excavation and surveyed



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SUE/GPS


It's Like Zero-ing in on the data you need!



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SUE/GPS

Plan Sheet Symbology Shows the Difference



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SUE/GPS

Solid Line indicates non-SUE utility designation - Someone's "Best Guess"

Recorded Water Line	-----	-----
Designated Water Line (S.U.E.*)	-----	-----
Sanitary Sewer	-----	-----
Recorded Sanitary Sewer Force Main	-----	-----
Designated Sanitary Sewer Force Main(S.U.E.*)	-----	-----
Recorded Gas Line	-----	-----
Designated Gas Line (S.U.E.*)	-----	-----

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SUE/GPS

Recorded Water Line	-----	-----
Designated Water Line (S.U.E.*)	-----	-----
Sanitary Sewer	-----	-----
Recorded Sanitary Sewer Force Main	-----	-----
Designated Sanitary Sewer Force Main(S.U.E.*)	-----	-----
Recorded Gas Line	-----	-----
Designated Gas Line (S.U.E.*)	-----	-----

Dashed Line indicates SUE designation/location - accurate to +/- 1' horizontally

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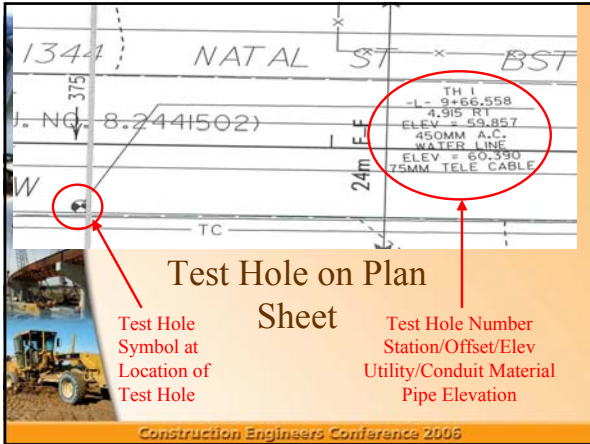
SUE/GPS

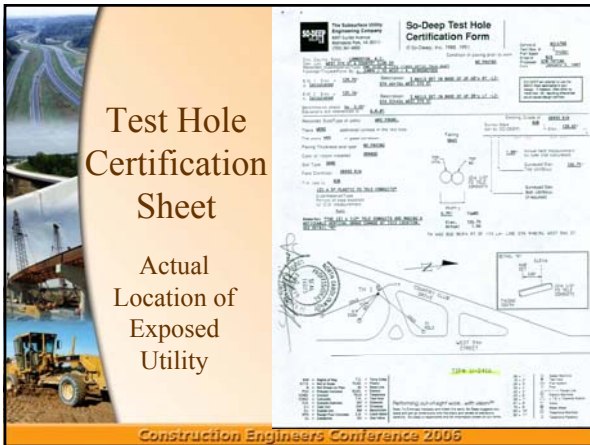
Level A - Test Holes

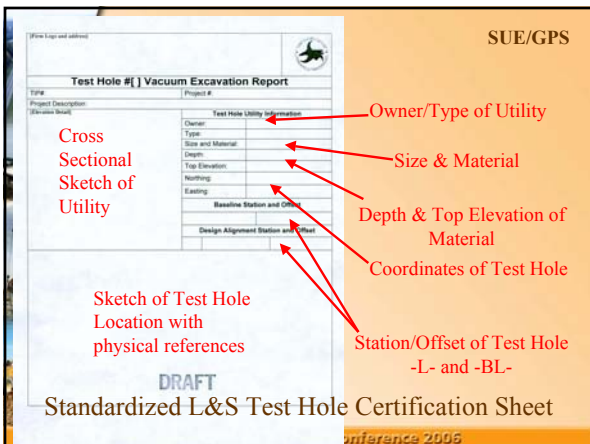
- Utility is exposed and surveyed
- Preliminary Test Holes during Initial Surveys gives designer approximate depths of utilities -
- A target for design depths
- Once actual point of conflict is determined, a second test hole at that point exposes the utility for exact location
- Ensures design misses utility or adjusts accordingly
- Contractor knows where the utility is
- May leave utility in place and build around it

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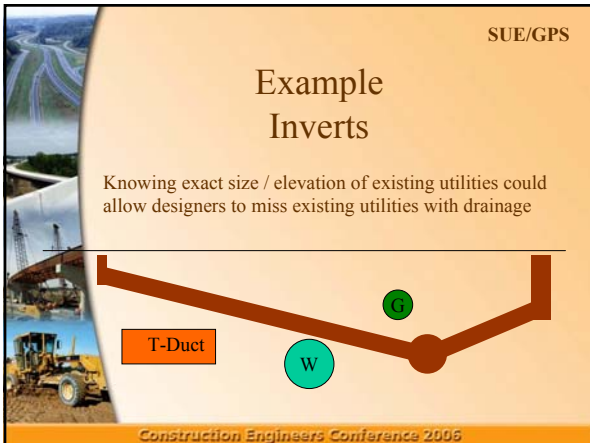


SUE/GPS

Standardized L&S Test Hole Certification Sheet

- Plans checked by L&S to ensure Test Holes are on plans
- Certification Sheet presented to Division Construction Engineer or Resident Engineer at Field Inspection
- Also to be found on Project Server/Project/Test Hole File

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SUE/GPS

Example Inverts

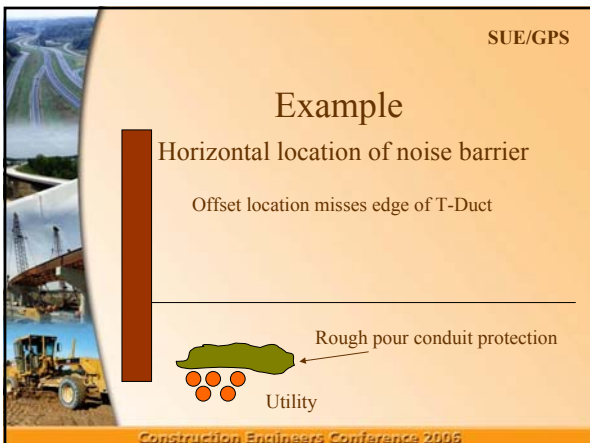
Knowing exact size / elevation of existing utilities could allow designers to miss existing utilities with drainage

T-Duct

W

G

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Example

Horizontal location of noise barrier

Offset location misses edge of T-Duct

Rough pour conduit protection

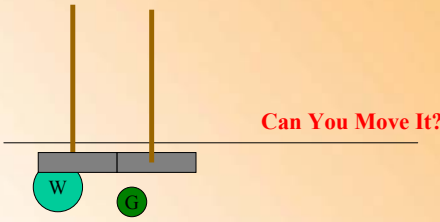
Utility

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Example
Signal Pole with Footing

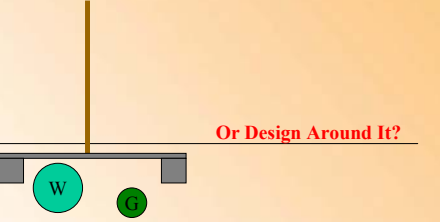


Can You Move It?

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Example
Signal Pole with Footing



Or Design Around It?

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SAMPLE COSTS OF UTILITY
RELOCATIONS (2000 Data)

Telephone

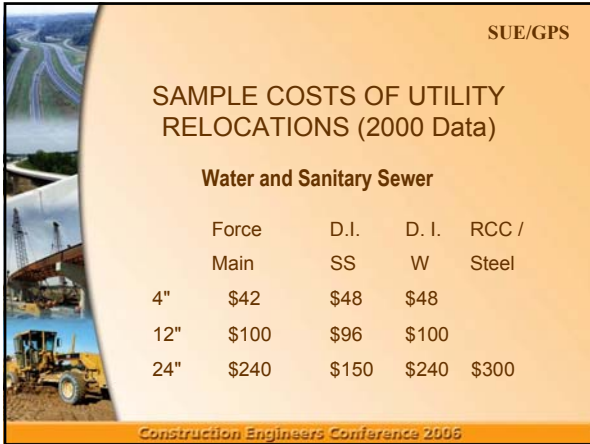
Manhole - \$20,000 (in place), \$10,000 (prefab)	} Direct Buried
Splice box - \$3,000	

Steel casing (open cut)

30" (room for 24 ducts)	\$300.00 per foot
20" (room for 9 ducts)	\$180.00 per foot
12" (room for 3 ducts)	\$150.00 per foot

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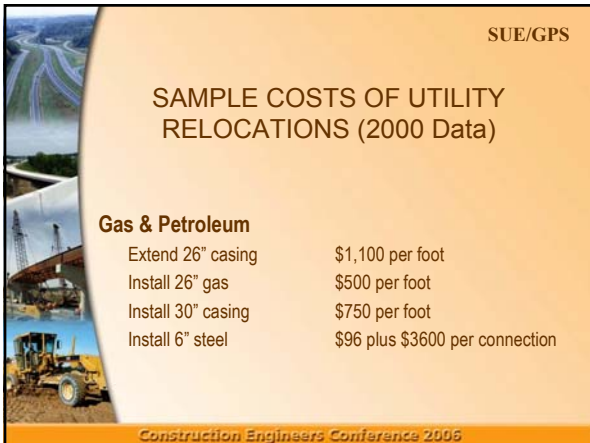
SUE/GPS

**SAMPLE COSTS OF UTILITY
RELOCATIONS (2000 Data)**

Water and Sanitary Sewer

	Force Main	D.I. SS	D. I. W	RCC / Steel
4"	\$42	\$48	\$48	
12"	\$100	\$96	\$100	
24"	\$240	\$150	\$240	\$300

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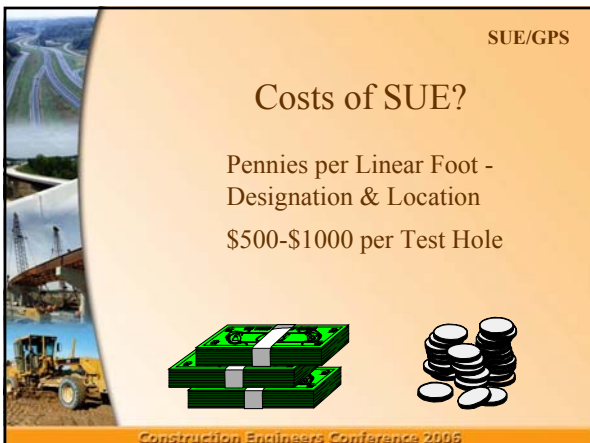
SUE/GPS

**SAMPLE COSTS OF UTILITY
RELOCATIONS (2000 Data)**

Gas & Petroleum

Extend 26" casing	\$1,100 per foot
Install 26" gas	\$500 per foot
Install 30" casing	\$750 per foot
Install 6" steel	\$96 plus \$3600 per connection

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SUE/GPS

Costs of SUE?


Pennies per Linear Foot -
Designation & Location

\$500-\$1000 per Test Hole

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SUE/GPS

Costs of Not Using SUE?


Each SUE Firm carries \$1,000,000 Liability. This should cover re-design or most of the costs of delays and claims based on wrong identification or location.



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SUE/GPS



A January 2000 FHWA / Purdue University study (Publication No. FHWA-IF-00-014) states the following:

“A savings of \$4.62 for every \$1.00 spent on SUE was quantified from a total of 71 projects. These projects had a combined construction value in excess of \$1 billion. The costs of obtaining Quality Level “B” (QL B) and Quality Level “A” (QL A) data on these 71 projects were less than 0.5 percent of the total construction costs, and it resulted in a construction savings of 1.9 percent over traditional Quality Level C (QL C) and/or Quality Level D(QL D) data.”

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SUE/GPS

One individual project had a \$206.00 to \$1.00 return on investment (North Carolina DOT).

Only 3 of 71 projects had a negative return on investment. The simple conclusion of this study is that SUE is a viable technologic practice that reduces project costs related to the risks associated with existing subsurface utilities and, when used in a systematic manner, will result in significant quantifiable and qualitative benefits.

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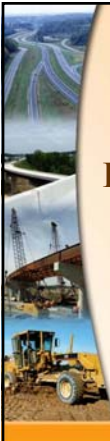


SUE/GPS


What Data is Available? Where?

- Data should be on plans
- L&S Staff should contact Resident prior to Preconstruction Meeting
- We'll pass on hard copies of Test Hole Certifications
- Also seeking ways to place this data on a server for your access, with web address on plans

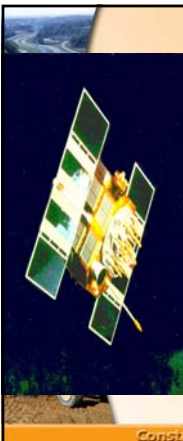
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Global Positioning System (GPS)



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SUE/GPS

What Is GPS?

- 32 satellites in a fixed height orbit, with known location
- Transmitting a signal to a receiver on the ground. This signal is basically a time stamp
- Receiver on the ground measures the time required for the signal to go from sender to receiver
- Distance = Time/Speed of Light
- Minimum 4 satellites to give good position (Three circles define one point - 4th provides time check)
- Survey grade receivers can receive more signals for very accurate location

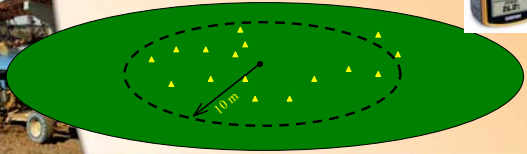
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SUE/GPS

Recreational Grade Accuracy

Autonomous Position
+/- 10 m (33 ft) error (horizontal)
+/- 15 m (52 ft) error (vertical)
May Be +/- 2 m (horizontal) within
5 years





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SUE/GPS

Mapping Accuracy

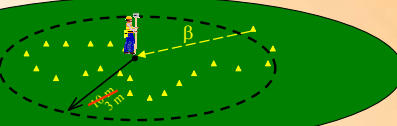
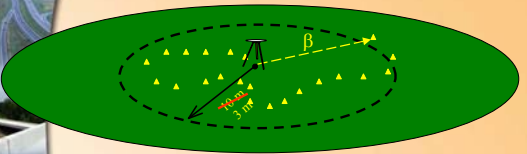
Submeter to 3 meter
Data is being corrected from
base station



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SUE/GPS

Base Station at Known Location (CORS) Rover Unit at Unknown Location



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Survey Accuracy

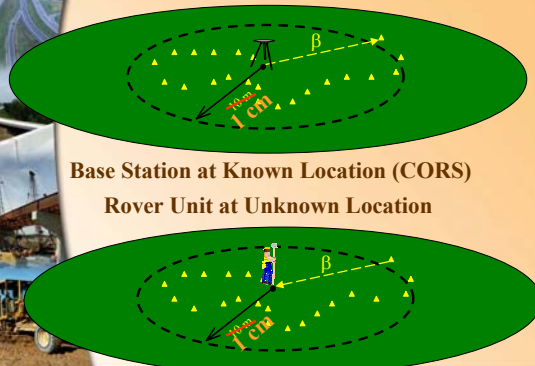
Uses more of the GPS signal
than Mapping
5 mm - 2 cm

Must have open view of the sky
Second receiver needed on site
or transmitted from
pre-established base



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SUE/GPS




Base Station at Known Location (CORS)
Rover Unit at Unknown Location

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Base Station Networks


Through post-processing or
transmission, the Base Station
provides the correction factor for
accurate Mapping and Survey Grade
GPS locations



Without a base, a \$25,000
receiver gives \$100 information!


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Tools of the Trade

RTK - Real Time Kinematic
Right Here
Right Now
No Going Back
to the office to process data



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Tools of the Trade - Base Stations

SUE/GPS

The Project-Specific Base
Local Control Possible
Provides Local Coverage
Limited Area
Requires Base and Transmitter/Receiver
Easy Set-up and Operation
Mobile
Owner-Operated



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Tools of the Trade - Base Stations

SUE/GPS

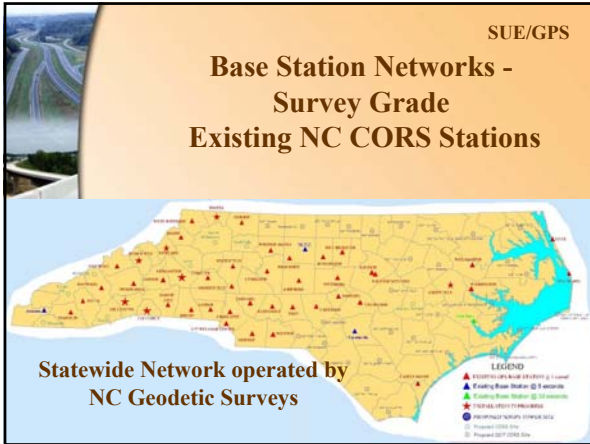
CORS - Continuously Operating Reference Station
A permanently mounted base station providing data for a known reference point. This data maybe transmitted or recorded, or both.

Tied to
**HARN - High Accuracy
Reference Network**
A network of extremely accurate
reference points, nationwide

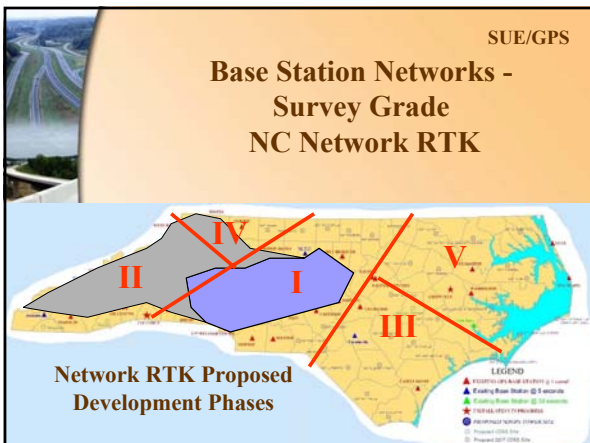


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Construction Stakeout With GPS







Construction Stakeout With GPS



SUE/GPS


Mapping Grade GPS in Construction: Estimating

- Paper plans and electronic alignment on a mapping grade GPS receiver



OR

- Electronic plans on a mapping grade GPS receiver

No need to stake the project for estimation purposes




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SUE/GPS

Survey Grade GPS in Construction Stakeout

Same Control as used in Design
Tying Project & Photo Controls
Clearing & Grubbing
Construction Staking
Underground Utility Locations -
Horizontal and Vertical
(Exposed Utility)
Quick and Accurate
No Need for Traversing
Smaller Survey Crews




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SUE/GPS


Survey Grade GPS in Construction Stakeout

- Coordinate Issues - Different Datums
- Tying Grid To Ground - How Do We Know What's Right?
- Good Communication - Design to Construction
- Equipment Calibration
- Control Data on Plans
- Electronic data transferred to contractor
- Must have knowledgeable users



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Construction Stakeout With GPS





SUE/GPS

Survey Grade GPS in Vehicle Guidance/Machine Control

- Blades and Dozers
- Manual or Automatic
- Accurately position the blade (0.05' horizontal, 0.10' vertical)
- Everything tied to one project control network

Allows use of digital terrain model



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SUE/GPS

Survey Grade GPS in Vehicle Guidance/Machine Control

- Faster, More Accurate
- Quantities - continuous measurement
- Line of sight not required
- Dramatically increases production (day/night)
- Dramatically reduces labor costs-layout, stakes



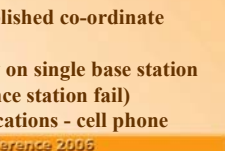
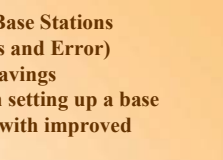
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SUE/GPS



Why Use Network RTK: Stake-Out or Vehicle Guidance

No Need for User-Owned Base Stations
(Reduced Equipment Costs and Error)
Equipment and time cost savings
Reduces time and errors in setting up a base
Extended operating range with improved accuracy
All users in common, established co-ordinate frame
Eliminates the dependency on single base station
(Back-ups should a reference station fail)
Uses established communications - cell phone



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Construction Stakeout With GPS



SUE/GPS

NC Network RTK

- NC Geodetic Surveys is Network Administrator (NCDOT contributed seed money)
- Public/Private (\$500 per rover 1-time fee)
- Network growth dependant upon available funds
- Additional Bases Stations required to completely cover NC
- Data Communication issues for NCDOT - Cell Phones

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SUE/GPS

Equipment Needs

- 5700 RTK GPS System (Base or Rover)
- 5800 RTK GPS Rover
- TSCe Controller or Trimble Recon Controller
- Either w/ GeoPak ...Maybe
- Cellular Phone (with Blue Tooth?)



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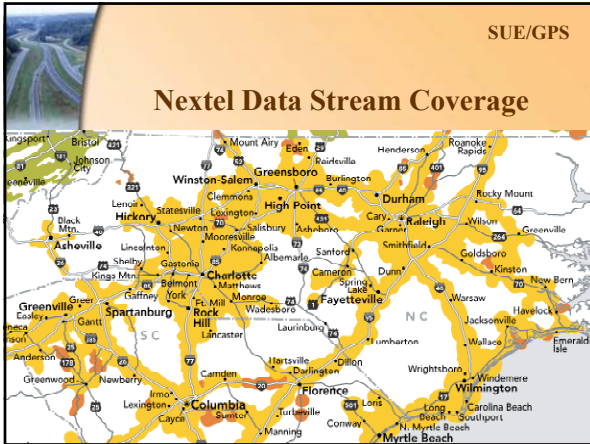
SUE/GPS

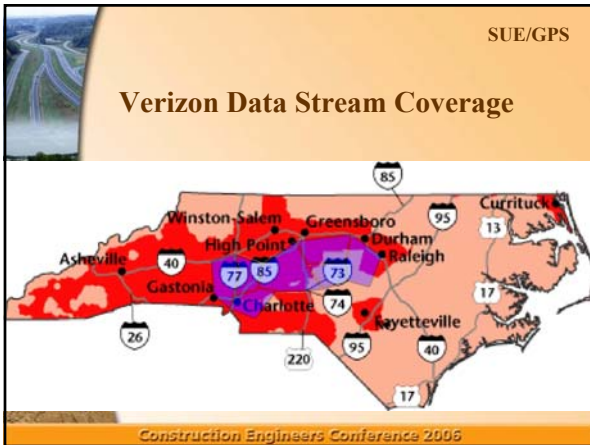
Cingular Data Stream Coverage



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SUE/GPS

Res. Engrs. with GPS Experience

Randy Midgette	Div 1 (Manteo)	(252) 331-4860
Chad Kimes	Div 2 (Greenville)	(252) 830-3495
Philip Johnson	Div 5 (Raleigh)	(919) 678-0444
Chris Kirkman	Div 7 (Greensboro)	(336) 334-3297
Ron Graham	Div 10 (Matthews)	(704) 847-5015
Larry Carpenter	Div 12 (Gastonia)	(704) 853-5381



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SUE/GPS

Or Contact L&S!!
Local Field Office or Raleigh

(We're from Raleigh - We're here to Help)



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